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Adapting Meaningful Strategies to Design two Undergraduate Organic Chemistry Laboratory Courses (Hybrid Learning)

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Herein describes the reasoning behind the approach and the employment of the present web-based course content in two of the undergraduate organic chemistry laboratory courses at the department of chemistry, Iowa State University (ISU). The design utilizes both virtual and in-person educational rudiments to enhance students' overall learning experience. This paper aims to assist the two courses overall and other instructors seeking to improve the effectiveness of their teaching.

Keywords

Educational Methods, Organic Chemistry, Internet/Web-Based Learning, Laboratory Instruction

Disciplines

Chemistry | Higher Education

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Introduction

A "blended" laboratory course is typically a course that is a hybrid between the traditional laboratory course and an online course. A blended approach has less frequent in-person meetings than a conventional face-to-face mode of delivery, permitting significant flexibility and allowing students to learn on their own time. Due to the COVID-19 pandemic, the undergraduate organic laboratory courses at ISU are currently web-enhanced (blended format) courses where the instructor has most of the instructional materials posted in the Canvas learning management system (LMS).[1, 2] The two courses are offered every semester as co-requisites to the corresponding lecture courses, with typically ~28 students in each section (course enrollments are included in the Table 1).[3] The laboratory class currently meets with a contact time equal to the credit hour associated with the course with alternative face-to-face and online lab every other week.

The first course (Laboratory in Organic Chemistry I) serves as an introduction to organic chemistry, with emphasis on the preparation, properties, and reactions of important classes of carbon compounds. Significant importance is placed on reaction mechanisms, stereochemistry, and functional group

characterizations. The laboratory additionally focuses on synthetic methods and techniques, thereby training learners to analyze compounds using classical and instrumental methods. During the second semester course (Laboratory in Organic Chemistry II), students perform experiments which continue to reinforce techniques and concepts learned during the previous semester. In addition, learning is more focused on synthesizing various organic compounds with a variety of functional groups, using several mechanisms. Student performance in both courses is evaluated based on pre- and post-laboratory assessments.

Table 1. Course Enrollments for Fall 2020 and Spring 2021.

Laboratory Course	Fall 2020	Spring 2021
Laboratory in Organic Chemistry I	~300	~150
Laboratory in Organic Chemistry II	~90	~150

Discussion

One of the significant changes in the design was to present the homepage in a more student-friendly "page" format instead of the previously used "modules" format, allowing for a more refined and comprehensive approach to presenting the course material (Figure 1). A series of short and engaging videos were added to the home page: (i) the *Orientation* video was included to assist all students in accessing the online class and making them feel comfortable moving into the initial modules of the course; (ii) the *Meet your Instructors* video was added to give students a chance to gauge the instructor's (and teaching assistants') personality, reducing any hesitance concerning the online/hybrid learning environment; and (iii) the *General Laboratory Tour* and the *Laboratory Safety Tour* videos covered common laboratory situations. Similar videos have been shown to acquaint and train students for upcoming laboratory sessions.[4] Besides, such pre-laboratory activities not only increase student confidence but also improve their overall university experience.[5] These videos also help the instructor induce interest in the course and explain how it is relevant to the students.

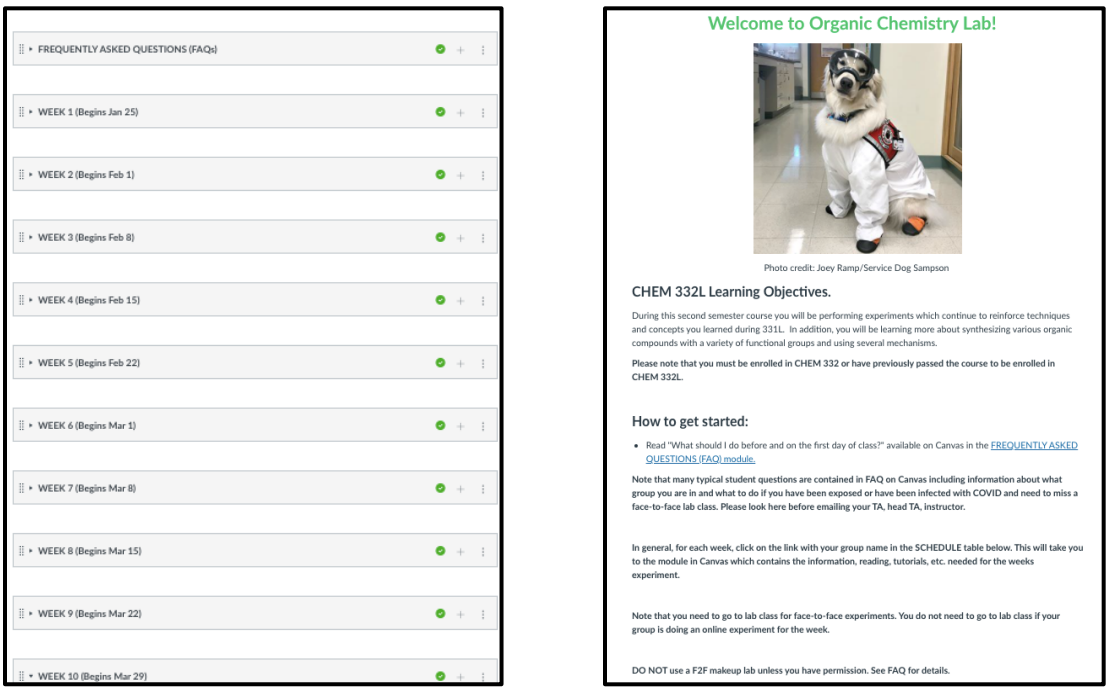

Figure 1. Previous (left) and new (right) homepage for Laboratory in Organic Chemistry II.

The course syllabus is considered to be one of the essential components of a hybrid course.[6] The previous syllabus was especially appraised for use in the hybrid laboratory class, explicitly stating the course grading policy and the academic misconduct statements, among other essential course overviews. A syllabus quiz was devised to verify student understanding of the critical components in the syllabus. The frequently asked questions (FAQ) page, containing several typical student questions, was made more user-friendly and easier to navigate. Some of the laboratory readings, assessments, and measurements criteria were also revisited and revised, keeping student learning goals in mind.[7, 8]

Conclusion

The abrupt interruption of teaching due to the COVID-19 pandemic has resulted in unique challenges; however, it has brought many lessons, enabling the development of strategies to enrich learners' whole learning experience. Though distant learning in the laboratory course cannot replace in-person laboratories, enhancements to hybrid learning can amplify student understanding. Based on students' and teaching assistants' feedback, the preparation for the upcoming laboratory program will continue to be modified accordingly by integrating both virtual and in-person components.

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3. The two laboratory courses are typically completed in a two semester sequence (Junior Level).

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